absence of Bacteria and other low organisms in infusions often bears little or no relation to the facilities for the admission of germs from the atmosphere, but seems to depend on a variety of special conditions only to be learnt by long practice. The temperature at which the infusion was made, its quantity, the presence of dense or rarefied air in the flask, a few degrees more or less of temperature of the room where the flasks are kept, and a variety of other circumstances, so affect the results, that in some cases organisms refuse to appear when there is every facility for the hypothetical germs to gain admission; while, as we have seen, they are often plentifully produced when every possible precaution is taken to keep them out and to destroy them. The only way of escaping from the results of such a series of experiments as that here recorded is by asserting that, although the *organisms* which are produced in the flasks are killed by a temperature much below that to which the flasks have been subjected, the *germs* from which they have been produced are not so killed. We are asked, therefore, to accept as facts three pure suppositions: first, that such excessively minute and simple organisms as Bacteria, whose only mode of multiplication is by fission or gemmation, have germs which possess different physical properties from themselves; secondly, that these germs, as well as many others, are omnipresent in the atmosphere; and, thirdly, that they are not injured by an exposure for four hours to vapour heated to over 300° F.; and, finally, we are to accept all these suppositions as facts in order to avoid admitting that specks of living protoplasm are originated *de novo* in some fluids just as specks of crystalline matter originate in other fluids, and although some organisms can be seen to make their appearance in fluids independently of all pre-existing visible germs, just as crystals do.

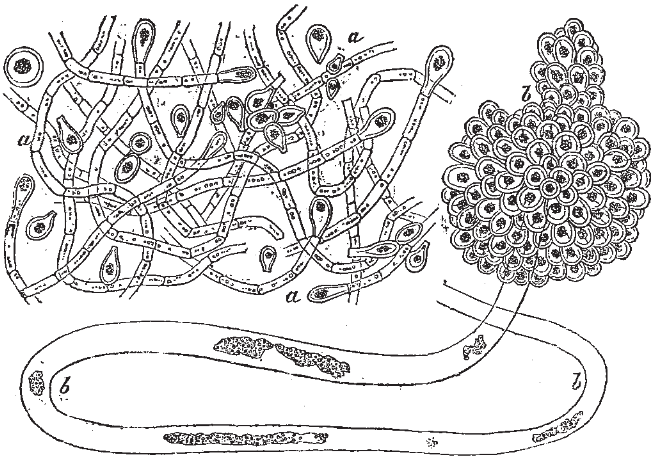

Fig. 4.—Fungus found in a Solution of Ammonic Tartrate and Sodic Phosphate (× 600).

It must, we think, be admitted that in the portion of his work we have now been considering, Dr. Bastian has fairly met and fully answered all the objections that were made to his earlier experiments. He has, moreover, shown the fallacy of many of the arguments of M. Pasteur and his supporters; and, by a series of careful and well-devised experiments, the results of which agree with those arrived at by a large number of other workers both in this country and on the Continent, has proved the *de novo* origin of various living organisms in air-tight flasks. This alone is a great step gained; but it is, as we propose to show in our next article, only the stepping-stone to more important observations and more startling facts.

DR. LIVINGSTONE

THE despatches and private correspondence of Dr. Livingstone, after a long detention, have at last been delivered, and we are now able to give extracts from the explorer's reports which throw further light on his discoveries. He appears to have ascertained, by a journey round the south-eastern side of Tanganyika, that that lake has no outlet. He has also explored the drainage to the eastward for nearly 600 miles. We learn also that his present object is to examine the hills to the south-west of Lake Bangweolo, where he had been told that there are four fountains, which he confusedly connects with the sources of the Nile, as described by Herodotus. There is marvellous heroism in this persistency, and it is sad to reflect that the grand old traveller is doomed to disappointment. But there can scarcely be any doubt that these rivers to the eastward of Tanganyika have no connection with the Nile. Apart from other considerations, Livingstone's own observations show that his Lualaba, where he saw it, was only at the same height above the sea as Gondokoro, and the error of his instrument would increase rather than diminish the height. This makes it impossible that his discoveries can be connected with the Nile. Doubtless the mass of waters is lost in some inland swamp.

The measures for Dr. Livingstone's relief were conducted with zeal and good faith, and he is now well supplied from stores sent up by Dr. Kirk and by his son. Mr. Stanley has also done excellent service in pushing on to Ujiji, in accompanying Livingstone to Unyanyembe, and in bringing home the letters and despatches. The President of the Geographical Society, in the name of the council, has promptly and cordially acknowledged this service, and the perseverance and energy with which it has been performed, in a letter addressed to Mr. Stanley as soon as the despatches were received. There was no delay or hesitation in giving him the credit that was his due; and equal promptitude has been shown by the Secretary of State for Foreign Affairs, whose letter has already been published. But the American correspondent's subsequent conduct, though doubtless agreeable to his employers, deserves no thanks from the countrymen of Livingstone. The ungenerous attack upon Dr. Kirk is sufficiently refuted by the evidence of Dr. Livingstone's own son, whose letters will, we trust, dispell the delusions with which his father's mind had been filled. Even now we can scarcely believe that Mr. Stanley is justified in his assertion that Dr. Livingstone, the great enemy of slavery, commissioned him to send up sets of slave chains to be used by Her

Majesty's Consul! The statement of Lieutenant Henn, which induced him to abandon the Relief Expedition, that Dr. Livingstone desired all such parties to be turned back, led directly to the miserable alternative of sending up supplies in charge of a native; while Mr. Stanley's secresy and concealment of all particulars respecting Livingstone's wants and intentions while at Zanzibar was unnecessary and injurious. These proceedings, the objects of which are transparently obvious, necessarily detract from the warmth of our gratitude to the man who has certainly done no small service in accompanying Livingstone to Unyanyembe, and in bringing home his letters and journal.

The supplies at Unyanyembe, and those procured from the funds of the Relief Expedition, and sent on by his son, will doubtless have enabled Livingstone to continue his exploration, and, though the disappointment to which his notions about the Nile sources must inevitably lead is to be regretted, there can be no doubt that his contemplated further discoveries will lead to valuable results, and we sincerely trust that the brave old traveller will, after one more difficult journey, live to be cordially welcomed home, and to see some good fruits from his truly heroic perseverance. We now proceed to give some extracts from his despatches.

Dr. Livingstone, in the following passage, describes his march from the ridge overhanging the western shore of Tanganyika to the great river Lualaba:—

"In going west of Bambarre, in order to embark on the Lualaba, I went down the Luamo, a river from 100 yards to 200 yards broad, which rises in the mountains opposite Ujiji, and flows across the great bend of the Lualaba. When near its confluence I found myself among people who had lately been maltreated by the slaves, and they naturally looked on me as of the same tribe as their persecutors. Africans are not generally unreasonable, though smarting under wrongs, if you can fairly make them understand your claim to innocence, and do not appear as having your 'back up.' The women here were particularly outspoken in asserting our identity with the cruel strangers. On calling to one vociferous lady, who gave me the head trader's name, to look at my colour and see if it were the same as his, she replied, with a bitter little laugh, 'Then you must be his father!' The worst the men did was to turn out in force, armed with their large spears and wooden shields, and show us out of their districts. Glad that no collision took place, we returned to Bambarre, and then, with our friend Muhamad, struck away due north, he to buy ivory, and I to reach another part of Lualaba and buy a canoe. The country is extremely beautiful, but difficult to travel over. The mountains of light grey granite stand like islands in new red sandstone, and mountain and valley are all clad in a mantle of different shades of green. The vegetation is indescribably rank. Through the grass—if grass it can be called, which is over half an inch in diameter in the stalk, and from 10 to 12 feet hight—nothing but elephants can walk. The leaves of this megatherium grass are armed with minute spikes, which, as we worm our way along elephant walks, rub disagreeebly on the side of the face where the gun is held, and the hand is made sore by fending it off the other side for hours. The rains were fairly set in by November, and in the mornings, or after a shower, these leaves were loaded with moisture, which wet us to the bone. The valleys are deeply undulating, and in each innumerable dells have to be crossed. There may be only a thread of water at the bottom, but the mud, mire, or (*Scottice*) 'glaur' is grievous; 30 or 40 yards of the path on each side of the stream are worked by the feet of passengers into an adhesive compound. By placing a foot on each side of the narrow way one may waddle a little distance along, but the rank crop of grasses, gingers, and bushes cannot spare the few inches of soil required for the side of the foot, and down he comes into the slough. The path often runs along the bed of the rivulet for 60 or more yards, as if he who first cut it out went that distance seeking for a part of the forest less dense for his axe. In other cases the Muale palm, from which here, as in Madagascar, grass cloth is woven, and called by the same name, 'lamba,' has taken possession of the valley. The leaf stalks, as thick as a strong man's arm, fall off and block up all passage, save by a path made and mixed up by the feet of elephants and buffaloes; the slough therein is groan-compelling and deep. Every now and then the traders, with rueful faces, stand panting; the sweat trickles down my face, and I suppose that I look as grim as they, though I try to cheer them with the hope that good prices will reward them at the coast for ivory obtained with so much toil. In some cases the subsoil has given way beneath the elephant's enormous weight; the deep hole is filled with mud, and one, taking it all to be about calf deep, steps in to the top of the thigh, and flaps on to a seat soft enough, but not luxurious; a merry laugh relaxes the facial muscles, though I have no other reason for it than that it is better to laugh than to cry.

"Between each district of Manyema large belts of the primeval forest still stand. Into these the sun, though vertical, cannot penetrate except by sending down at midday thin pencils of rays into the gloom. The rain-water stands for months in stagnant pools made by the feet of elephants; and the dead leaves decay on the damp soil, and make the water of the numerous rivulets of the colour of strong tea. The climbing plants, from the size of whipcord to that of a man-o'-war's hawsers, are so numerous that the ancient path is the only passage. When one of the giant trees falls across the road it forms a wall breast high to be climbed over, and the mass of tangled ropes brought down makes cutting a path around it a work of time which travellers never undertake."

In another despatch we have a more general review of the results of his explorations, as follows:—"I have ascertained that the watershed of the Nile is a broad upland between 10° and 12° south latitude, and from 4,000 feet to 5,000 ft. above the level of the sea. Mountains stand on it at various points, which, though not apparently very high, are between 6,000 feet and 7,000 feet of actual altitude. The watershed is over 700 miles in length, from west to east. The springs that rise on it are almost innumerable—that is, it would take a large part of a man's life to count them. A bird's-eye view of some parts of the watershed would resemble the frost vegetation on window-panes. They all begin in an ooze at the head of a slightly depressed valley. A few hundred yards down, the quantity of water from oozing earthen sponge forms a brisk perennial burn or brook a few feet broad and deep enough to require a bridge. These are the ultimate or primary sources of the great rivers that flow to the north in the great Nile valley. The primaries unite and form streams in general larger than the Isis at Oxford or Avon at Hamilton, and may be called secondary sources. They never dry, but unite again into four large lines of drainage, the head waters or mains of the river of Egypt. These four are each called by the natives Lualaba, which, if not too pedantic, may be spoken of as lacustrine rivers, extant specimens of those which, in pre-historic times, abounded in Africa, and which in the south are still called by Bechuanas 'Melapo,' in the north, by Arabs, 'Wadys;' both words meaning the same thing—river-bed in which no water ever now flows. Two of the four great rivers mentioned fall into the central Lualaba, or Webb's Lake River, and then we have but two main lines of drainage as depicted nearly by Ptolemy. The prevailing winds on the watershed are from the south-east. This is easily observed by the direction of the branches, and the humidity of the climate is apparent in the number of lichens, which make the upland forest look like the mangrove swamps on the coast. In passing over 60 miles of latitude, I waded

32 primary sources from calf to waist deep, and requiring from 20 minutes to an hour and a quarter to cross stream and sponge; this would give about one source to every two miles. A Suaheli friend, in passing along part of the Lake Bangweolo during six days, counted 23 from thigh to waist deep. This lake is on the watershed, for the village which I observed on its north-west shore was a few seconds into 11° south, and its southern shores and springs and rivulets are certainly in 12° south. I tried to cross it in order to measure the breadth accurately. The first stage to an inhabited island was about 24 miles. From the highest point here the tops of the trees, evidently lifted by the mirage, could be seen on the second stage and the third stage; the mainland was said to be as far as this beyond it. But my canoe men had stolen the canoe, and got a hint that the real owners were in pursuit, and got into a flurry to return home. 'They would come back for me in a few days truly,' but I had only my coverlet left to hire another craft, if they should leave me in this wide expanse of water, and being 4,000 feet above the sea, it was very cold, so I returned. The length of this lake is, at a very moderate estimate, 150 miles. It gives forth a large body of water in the Luapula; yet lakes are in no sense sources, for no large river begins in a lake, but this and others serve an important purpose in the phenomena of the Nile. It is one large lake, and unlike the Okara, which, according to Suaheli, who travelled long in our company, is three or four lakes run into one huge Victoria Nyanza, gives out a large river which, on departing out of Moero, is still larger. These men had spent many years east of Okara, and could scarcely be mistaken in saying that of the three or four lakes there only one, the Okara, gives out its waters to the north. The 'White Nile' of Speke, less by a full half than the Shire out of Nyassa (for it is only 80 or 90 yards broad), can scarcely be named in comparison with the central or Webb's Lualaba, of from 2,000 to 6,000 yards, in relation to the phenomena of the Nile. The structure and economy of the watershed answer very much the same end as the great lacustrine rivers, but I cannot at present copy a lost despatch which explained that. The mountains on the watershed are probably what Ptolemy, for reasons now unknown, called the Mountains of the Moon. From their bases I found that the springs of the Nile do unquestionably arise. This is just what Ptolemy put down, and is true geography. We must accept the fountains, and nobody but Philistines will reject the mountains, though we cannot conjecture the reason for the name. Mounts Kenia and Kilmanjaro are said to be snow-capped, but they are so far from the sources and send no water to any part of the Nile, they could never have been meant by the correct ancient explorers, from whom Ptolemy and his predecessors gleaned their true geography, so different from the trash that passes current in modern times. Before leaving the subject of the watershed, I may add that I know about 600 miles of it, but am not yet satisfied, for, unfortunately, the seventh hundred is the most interesting of the whole. I have a very strong impression that in the last hundred miles the fountains of the Nile mentioned to Herodotus by the Secretary of Minerva in the city of Sais do arise, not like all the rest, from oozing earthen sponges, but from an earthen mound, and half the water flows northward to Egypt, the other half south to Inner Ethiopia. These fountains, at no great distance off, become large rivers, though at the mound they are not more than ten miles apart. That is, one fountain rising on the north-east of the mound becomes Bartle Frere's Lualaba, and it flows into one of the lakes proper, Kamolondo, of the central line of drainage; Webb's Lualaba, the second fountain rising on the north-west, becomes (Sir Paraffin) Young's Lualaba, which, passing through Lake Lincoln and becoming Loeki or Lomame, and joining the central line too, goes north to Egypt. The third fountain on the south-west, Palmerston's, becomes the Liambia or Upper Zambesi; while the fourth, Oswell's, fountain becomes the Kafue, and falls into Zambesi in Inner Ethiopia. More time has been spent in the exploration than I ever anticipated."

He then sums up the results of his work as follows:—"The Geographical results of four arduous trips in different directions in the Manyema country are briefly as follows:— The great river, Webb's Lualaba, in the centre of the Nile valley, makes a great bend to the west, soon after leaving Lake Moero, of at least 180 miles; then turning to the north for some distance, it makes another large sweep west of about 120 miles, in the course of which about 30 miles of southing are made; it then draws round to north-east, receives the Lomame, or Loeki, a large river which flows through Lake Lincoln. After the union a large lake is formed, with many inhabited islands in it, but this has still to be explored. It is the fourth large lake in the central line of drainage, and cannot be Lake Albert; for, assuming Speke's longitude of Ujiji to be pretty correct, and my reckoning not enormously wrong, the great central lacustrine river is about 5° west of Upper and Lower Tanganyika. In my attempts to penetrate further and further I had but little hope of ultimate success, for the great amount of westing led to a continual effort to suspend the judgment, lest, after all, I might be exploring the Congo instead of the Nile, and it was only after the two great western drains fell into the central main, and left but the two great lacustrine rivers of Ptolemy, that I felt pretty sure of being on the right track. The great bends west probably form one side of the rivers above that geographical loop, the other side Upper Tanganyika and the Lake River Albert. A waterfall is reported to exist between Tanganyika and Albert Nyanza, but I could not go to it; nor have I seen the connecting link between the two—the upper side of the loop—though I believe it exists."

His despatches conclude with the following account of his future intentions:—"Geographers will be interested to know the plan I propose to follow. I shall at present avoid Ujiji, and go about south-west from this to Fipa, which is east of and near the south end of Tanganyika; then round the same south end, only touching it again at Pambette, thence resuming the south-west course to cross the Chambeze and proceed along the southern shores of Lake Bangweolo, which being in latitude 12° south, the course will be due west to the ancient fountains of Herodotus. From them it is about ten days north to Katanga, the copper mines of which have been worked for ages. The malachite ore is described as so abundant, it can only be mentioned by the coalheavers' phrase, 'practically inexhaustible.' About ten days north-east of Katanga very extensive underground rock excavations deserve attention as very ancient, the natives ascribing their formation to the Deity alone. They are remarkable for all having water laid on in running streams, and the inhabitants of large districts can all take refuge in them in case of invasion. Returning from them to Katanga, 12 days N.N.W. take to the southern end of Lake Lincoln. I wish to go down through it to the Lomame, and into Webb's Lualaba and home. I was mistaken in the information that a waterfall existed between Tanganyika and Albert Nyanza. Tanganyika is of no interest, except in a very remote degree in connection with the sources of the Nile. But what if I am mistaken, too, about the ancient fountain? Then we shall see! I know the rivers they are said to form—two north and two south—and in battling down the central line of drainage, the enormous amount of westing it made caused me at times to feel as if running my head against a stone wall. It might after all be the Congo, and who would care to run the risk of being put into a cannibal pot and be converted into black man for anything less than the grand old Nile? But when I found that Lualaba forsook its westing, and received through Lake Kamolondo Bartle Frere's great river, and that afterwards farther down it takes in Young's great stream through Lake Lincoln, I ventured to think that I was on the right track. Two great rivers arise somewhere on the western end of the watershed, and flow north—to Egypt (?). Two other large rivers rise in the same quarter and flow south, as the Zambesi, or Liambai, and the Kafue, into Inner Ethiopia. Yet I speak with diffidence, for I have no affinity with an untravelled would-be geographer who used to swear to the fancies he collected from slaves till he became blue in the face. I know about six hundred miles of the watershed pretty fairly. I turn to the seventh hundred miles with pleasure and hope. I want no companion now, though discovery means hard work. Some can make what they call theoretical discoveries by dreaming. I should like to offer a prize for an explanation of the correlation of the structure and economy of the watershed with the structure and economy of the great lacustrine rivers in the production of the phenomena of the Nile. The prize cannot be undervalued by competitors even who have only dreamed of what has given me very great trouble, though they may have hit on the division of labour in dreaming, and each discovered one or two hundred miles. In the actual discovery so far, I went two years and six months without once tasting tea, coffee, or sugar; and, except at Ujiji, have fed on buffaloes, rhinoceros, elephants, hippopotami, and cattle of that sort; and have come to believe that English roast beef and plum pudding must be the real genuine theobroma, the food of the gods, and I offer to all successful competitors a glorious feast of beefsteaks and stout. No competition will be allowed after I have published my own explanation, on pain of immediate execution without benefit of clergy! I send home my journal by Mr. Stanley, sealed, to my daughter Agnes. It is one of Letts' large folio diaries, and is full except a few (five) pages reserved for altitudes which I cannot at present copy. It contains a few private memoranda for my family alone, and I adopt this course in order to secure it from risk in my concluding trip."

NOTES

We are in a storm of Congresses. Scarcely has the British Archæological Institute finished its work at Southampton before the British Archæological Association, the Iron and Steel Institute, and the British Medical Association have thrown Wolverhampton, Glasgow, and Birmingham respectively into unwonted excitement; while by this time next week the British Association will be in full swing at Brighton. With regard to this latter Congress, we are happy to announce that admirable arrangements for the reception of visitors are being made, and that a large and satisfactory meeting, under the presidency of Dr. Carpenter, may be anticipated.

At the moment of going to press we hear that a M. Delaunay, "director of the Astronomical Observatory" (*sic*), has been drowned by the upsetting of a boat at Cherbourg. We sincerely trust this does not refer to the distinguished director of the Observatory of Paris. But the telegram is ominous.

The French Association for the Advancement of Science will hold its first annual meeting at Bordeaux, from the 5th to the 12th of September. The Administrative Council, consisting of MM. Claude Bernard, Broca, Delaunay, A. d'Eichthal, De Quatrefages, Wurtz, Cornu, secretary of the Association, Masson, treasurer, and Gariel, secretary of the Council, have issued a circular inviting many of our most eminent men of science to be present; and, as the new French society is based upon an old English one, it will be both graceful and useful that as many shall attend as possible. We have also received the first publication of the society, containing a *compte rendu* of the inauguration meeting of the society, held in April in Paris, and the statutes of the society, which have already appeared in Nature nearly in their final form. We wish the society every success; its object is essentially decentralisation. Would we in England were in a position to decentralise!

Dr. Cobbold, F.R.S., has been appointed to a Professorship of Helminthology at the Royal Veterinary College. During the ensuing winter months he will give a course of lectures on the Parasites and Parasitic Diseases of our domesticated animals.

Dr. Brown-Sequard has resigned the Chair of Comparative and Experimental Pathology in connection with the Faculty of Medicine in Paris, which he has occupied several years. M. Vulpian has applied for the Chair.

Dr. Gerhart, of Jena, has been appointed successor to Dr. Bamberger as Professor of Clinical Medicine at Würzburg.

We regret to learn that Mr. M. C. Webster, the acting collector at Trichinopoli, to whose exertions the Eclipse Expedition owed so much, has been ordered home without delay for two years on sick certificate.

One of the most recent applications of science to practical purposes, which, according to most people is the only part of science which is worth anything, is sufficiently curious. In the "Mors Electrique" of M. Sidot, we have electricity employed in a manner to combine the study of electricity with a ride or drive into the country in company with a restive horse. Nothing is more simple. In the carriage, or even in the saddle, we have a pile *système hermétique Trouvé*, and a small induction coil, along the reins the magic wires are laid, and on either side the animal's lower jaw we have a *couronne metallique*. These are the data. The inventor is under the impression that when the quadruped's motion becomes too rapid it will be instantly brought to zero by the passage of the spark through the aforesaid jaw, but we do not learn that he has tried it. We would suggest that in a cavalry charge it would be most effective. This should be tried at the forthcoming manœuvres. In war the principle might be extended. The horses might be armed unicorn-wise, with blunderbusses and Abel's fuzes, the *couronne metallique* being of course removed from the lower jaw to the novel weapon. Probably in this way the functions of the riders might be abolished altogether; this would bring about a great saving in the army estimates, and in this way cause the Government to think that there may be something in science after all.

No. 6 of the Illustrated Catalogue of the Museum of Comparative Zoology at Harvard College, just come to hand, contains the supplement to the Ophiuridæ and Astrophytidæ by Theodore Lyman, with two plates, in which figures are given of the most important of the singular deep-sea Ophiurans brought up by the dredgings off the coast of Florida, and described in Bulletin No. 10, vol. i. of the Catalogue.

Our common sparrow, as most of our readers are aware, has been for some time naturalised in the New York parks and elsewhere in the United States, for the purpose of keeping in check a plague of caterpillars, in which office it is doing yeoman service. We regret to learn by a paragraph in *The New York Industrial Monthly* that our compatriots are in danger of extermination by a race of feathered rowdies, also bent upon turning the balance of creation their own way. The sparrow's enemy is the great northern shrike; and the *Industrial Monthly* states that one of these "butcher-birds," which eat only the brains of their victims, recently killed a sparrow "by squeezing its head into a crotch made by the fork of two branches, each about half an inch thick."